AN EVALUATION OF OVERWINTER DRAWDOWN AS AN AQUATIC PLANT CONTROL METHOD FOR THE KAWARTHA LAKES

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by

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INTRODUCTION

Overwinter drawdown or "downwatering" to expose aquatic plants to drying and/or freezing conditions has been used in some areas of North America as an effective method for controlling nuisance vegetation in lakes. Each year, water levels in the Kawartha Lakes are dropped three to four feet during the time January to March to accommodate the spring freshette. An earlier drawdown, commencing immediately following the closing of the Trent System for navigation, has been advocated as a method of controlling problem vegetation in the Kawartha Lakes. The pros and cons of this method were reviewed in a report to the CORTS Agreement Board by the sub-committee on aquatic plant problems (February, 1976) and recommendations made for further study.

Water levels in two of the Kawartha Lakes (Canal and Mitchell) are routinely lowered immediately following the termination of the navigation season in October and these lakes were used for field studies to assess the effectiveness of downwatering. To supplement the field data, a series of tests exposing milfoil, (Myriophyllum spicatum) plants to varying periods of freezing and drying were carried out in the laboratory.

METHODS

a) Field Methods

Canal and Mitchell Lakes were visited in December 1975, to select appropriate sites in the exposed portions of the lakes for subsequent study. A second visit was made in February 1976 to measure frost depths at these pre-selected sites. In the summer of 1976, both lakes were visited on two separate occasions (June and August) to determine plant biomass, species composition and percent bottom cover at stations located both within the drawdown area and in deeper portions of the lakes (Figures 1 and 2). Average plant biomass for each station was obtained by collecting all plant material growing within 10 randomly placed ¼ m^2 quadrats and determining the fresh weight. Dry weight of the plant material was based on one representative sample from each station, which was dried at 105°C to a constant weight.

b) Laboratory Methods

A series of *M. spicatum* plants with complete root systems were collected from Buckhorn Lake in early April and transferred to the laboratory in Toronto. Ten plants were rooted in lake sediment in a large box and allowed to dry under laboratory conditions. At intervals of 2, 4, 6 and 8 weeks, two plants were removed from the box and placed in 5 gallon jars containing standard growth media.

A second series of plants were frozen in plastic bags at (-)20°C. Two plants were removed at each two week interval and placed in jars of growth media.

The effects of freezing and drying were assessed visually as presence or absence of growth following a period of one month in the growth media.

RESULTS

a) Water Level Manipulations and Depth of Frost Penetration

Water level changes in the Kawartha Lakes are regulated by the federal government through the Trent-Severn Waterway Authority in Peterborough, Ontario. Information on variations between summer and winter water levels in the Kawartha Lakes is provided in Table 1. With the exception of Canal and Mitchell Lakes, water levels are dropped gradually between January and March to accommodate spring runoff. Water levels in Canal and Mitchell Lakes are normally lowered by three feet commencing in mid-October. In 1975, however, water levels were dropped by an additional one to two feet to facilitate lock repairs.

To assess the degree of freezing in the exposed sediments of these lakes, the depth of frost penetration was measured in February of 1976. In both lakes, frost depths in the fully exposed areas varied between six and twelve inches. Sediments in the area which were still covered with three to four inches of water were generally frozen to similar depths. In the slightly deeper sections of the lakes, ice cover varied between three to six inches with two to three inches of water underlying the ice. The deepest sections of the lakes had two to three feet of ice overlying the water.

b) Plant Growths in Canal and Mitchell Lakes During 1976

Data on the plant populations in Canal Lake, collected during June and August surveys in 1976 is summarized in Table 2. In June, the shallower sections of the lake (depths less than five feet) were populated by several species of pondweeds including, *Potamogeton strictifolius*, *P. pectinatus* and *P. zosteriformis*. Other common plants included *Chara* spp. and *Heteranthera dubia*. *Elodea canadensis* was found throughout the lake, often in pure monocultures. The deeper sections of the lake (depths greater than five feet) were dominated by eurasian milfoil, *Myriophyllum spicatum*. These plants usually consisted of ten or more stems arising from a large root structure.

Specie composition in August was markedly different, with a pronounced decline of pondweeds in the shallower waters. This decline is attributed to the life cycle of some pondweed species which mature early in the season and die-back by mid-summer. Eurasian milfoil, M. spicatum was found at most of the shallow water sampling stations, although the plants had fewer stems and smaller root structures than the deeper water forms. At the deep water stations of the lake, the plant communities were still dominated by M. spicatum and exhibited a slight increase in biomass. On the other hand, biomass values and the estimated percent bottom cover at the shallow water stations were lower in August, possibly due to the previously mentioned die-back of some of the pondweed species.

In Mitchell Lake (Table 3) the dominant plant specie in June, 1976 was P. richardsonii. Other common species included M. exalbescens, P. robinisii, P. amplifolius, E. canadensis, Chara spp. and Vallisneria americana. Only a few isolated plants of M. spicatum were found in the lake, with none present at the sampling stations. By August, P. richardsonii had died back and the late maturing V. americana was dominant throughout the lake. Najas flexilus, M. exalbescens and Chara spp. were also prominant. Both the plant biomass and the estimated percent bottom cover increased significantly in August at both shallow and deep water stations.

c) Laboratory Studies

Eurasian milfoil plants which were placed in plastic bags and frozen at -20°C showed considerable tissue damage on thawing and failed to produce any growth when transferred into jars of prepared media. Milfoil plants rooted in lake sediment and left to dry at normal room temperature, adopted a semi-terrestrial form which enabled them to withstand long periods without overlying water. The semi-terrestrial form was characterized by extremely reduced stem and leaflet size. When transferred to the growth media following drying intervals of one, two and four weeks, the plants reverted to their aquatic form and produced healthy growth. No growth was observed on plants which were transferred to the media after drying intervals of six and eight weeks.

DISCUSSION

The manipulation of water levels to expose aquatic plants to freezing or drying has been frequently advocated as an effective management technique for controlling problem weed growths. In the Tennessee Valley Authority reservoirs, lowering of the water levels over the winter months appears to be an effective method of plant control resulting in the eradication of water milfoil in the dewatered zone, except in areas which remain damp (Smith et al. 1967). For effective control, a minimum drawdown amplitude of six feet has been suggested (Stanley et al. 1974). Studies carried out by the Tennessee Valley Authority suggest minimum drying period of twenty-one days to kill water milfoil and conclude that the drying of the root system is the important killing factor rather than freezing (Smith 1963). In subsequent studies Stanley (1976) demonstrated that the biomass of eurasian milfoil decreased with decreasing temperature and increasing exposure time. In Louisiana, Lantz et al. (1964) reported that summer drawdown over three successive years reduced plant growths in Anacoco Lake by 90%. Both fall and summer downwatering reduced vegetation by 50% in Lafourche Lake. In the Murphy Flowage, Wisconsin, Beard (1973) found significantly reduced growths of <u>Ceratophyllum demersum</u>, <u>Myriophyllum</u> spp., <u>Potamogeton robbinsii</u> and <u>P. amplifolius</u> following overwinter drawdown. However, re-invasion by resistant species (<u>N. flexilus</u>, <u>Bidens beckii</u>, and <u>P. diversifolius</u>) was apparent following a second drawdown. The author also reported algal bloom conditions one year after the reduction in macrophyte growth.

In a similar study in the Mondeaux Flowage, Nicholls (1975) found plant stem densities were reduced by one half in the littoral zone following an overwinter drawdown. A second drawdown provided little additional control and pre-drawdown abundances of vegetation were observed one year after drawdown ceased with <u>C. demersum</u> replacing <u>P. robbinsii</u> as the dominant plant specie. The author concluded that the rapid re-invasion of vegetation would dictate repeated drawdowns, since subsequent drawdowns would diminish in effectiveness as tolerant species replace the susceptible plants. He recommended the use of drawdown every second or third year with application of alternate weed control techniques in the interim periods.

In Canal and Mitchell Lakes, downwatering cannot be viewed as an

effective method of control since both lakes are extremely weedy with an estimated 86% and 88% of the total areas of the lakes populated by aquatic plants (CORTS report 1976). Similarly, plant biomass values both in the dewatered zones and in the deeper waters are comparable to values reported for other weed infested lakes on the Kawartha System (Ministry of the Environment report 1976). Data from Canal Lake, however, suggests a possible effect of downwatering on the growth of M. spicatum since the plant was absent from the shallower stations during the June survey. The milfoil plants found in shallow water during August were characterized by fewer stems and smaller root structures than the well established deep water forms, suggesting the possibility that the plants had drifted in from adjacent areas. The reasons for the virtual absence of M. spicatum in Mitchell Lake are not known at this time. Efforts will be made during 1977 to determine the reasons for the preferential growth of M. exalbescens in this lake.

Althouth the laboratory studies showed conclusively that dewatered milfoil plants can be killed by dessication, the results were not unexpected since the sediments in which the plants were rooted contained virtually 0% moisture content after a six week interval, a condition not likely to be simulated in a natural environment. As long as some degree of moisture was present in the sediments, the plants merely adopted a semi-terrestrial form and reverted to the aquatic form when transferred to the growth media. The results of the freezing experiment were inconclusive since the rapid freezing of the plant material at -20°C caused major tissue damage. This type of effect is unlikely to occur in a natural situation where temperatures decline more gradually and the plant structures are protected by the sediments and snow accumulations.

Based on the present studies it is apparent that an earlier (mid-October) drawdown does not offer an ideal solution for the aquatic plant problems in the Kawartha Lakes since many of the shallow areas which will be exposed are already populated by mixed plant communities, including numerous annual plants. As pointed out by Nicholls (1975), repeated drawdowns will diminish in effectiveness as tolerant species replace susceptible species. Many of the annual plant species would fall within the drawdown-tolerant category since they can mature and deposit viable seeds in the sediment during the summer months. In shoreline areas where M. spicatum is prevalent it is possible that some initial control can be achieved. The benefits, however, will be rapidly negated either

by re-invasion of milfoil from adjacent areas or by a shift to tolerant species following repeated drawdowns, as evidenced by the study in Canal Lake.

The questionable value of downwatering as a method of weed control is further substantiated by information on two Ontario reservoirs. Valens Reservoir in Wentworth County is heavily infested with pondweeds, Chara sp., Elodea canadensis and Myriophyllum exalbescens despite the annual practice of lowering water levels in mid-October. In Lake Eugene (Grey County) water level fluctuations are regulated by hydro generating demands and as a result are variable from year to year (i.e. in 1973 water level lowered by two and one half feet by early November; in 1974 lowered by two feet by early December and in 1975 dropped by three and one half feet by early December). Plant sampling carried out during the summer of 1976 showed heavy infestations throughout the lake, except in areas where the water depth exceeded ten feet. Both M. spicatum and M. verticillatum were common throughout the lake.

In addition to the questionable value of downwatering as a weed control measure in the Kawartha Lakes, other potential detrimental side-effects must be given consideration. Many of the problems, including the costs of reduced generating power, have been previously discussed in the CORTS report. The possibilities of damage to private property (docks and boat houses) was well illustrated by an early fall drawdown in Balsam Lake in 1968 when property damage generated a flood of public complaints. Another major concern involves the possibilities of fish kills resulting from reduced oxygen levels. A major fish kill is known to have occurred in Mitchell Lake following a simultaneous drawdown of both Balsam and Mitchell Lakes without the operation of the guard gate at Kirkfield. This action resulted in the trapping of fish in the deeper waters of Mitchell Lake which were lacking in oxygen content (Ministry of Natural Resources file information). Although an actual fish kill was not observed in the Mondeaux Flowage, Nicholls (1975) reported that dissolved oxygen concentrations approached levels considered critical for fish survival.

CONCLUSIONS

The use of an early fall drawdown as weed control technique in the Kawartha Lakes is considered to be of little value for the following reasons:

a) There was failure of this technique to significantly curtail plant growths in Canal and Mitchell Lakes,

b) Any possible reductions of M. spicatum in shallow shoreline areas will be rapidly negated by re-infestation from adjacent areas or by a shift to resistant species following successive drawdowns,

c) There is possibility of detrimental side-effects including fish kills and damage to private docks and boat houses.

Table 1: Average Annual Variations in Water Levels in the Kawartha Lakes. (*A.S.L. - above sea level).

Lake	Average Levels A.S.L.* (feet)	Average Levels A.S.L.* (feet)	Drawdown (feet)	Lowest Potential Sill Level (feet)
Canal	791.33-791.66	788.50	2.83	778.85
Mitchell	840.63-840.71	837.63	3.00	832.62
Balsam	840.63-840.71	837.63	3.00	832.62
Cameron	836.67-836.92	835.42	1.25	827.80
Scugog	819.74-820.20	818-62	1.12	814.80
Sturgeon	812.96-813.05	811.30	1.66	803.20
Buckhorn	807.06-807.56	803.56	3.50	796.87
Lower Buckhorn	796.04-796.29	791.10±	4.94±	786.33
Lovesick	792.30-792.46	790.00±	2.30±	785.37
Stony & Clear	768.11-769.11	766.03	2.08	757.61
Katchewanooka	761.12-761.45	760.12	1.00	603.45
Rice	612.38-612.80	Same	0.00	603.45

Table 2: Aquatic Plant Growths in Canal Lake - 1976.

JUNE

Station Nos	Water Depth (feet)	Dominant Species	Bottom Cover (%)	Wet Weight (g/m^2)	Dry Weight (g/m^2)
1,2,9 and 11	>5	*M. spicatum*	50	1271	184
8 and 10	4-5	*E. canadensis*	95	1992	312
3, 4 and 7	3-4	*Potamogeton* spp. *E. canadensis* *Chara* spp.	85	1076	164
5 and 6	2-3	*Potamogeton* spp.	85	620	84

AUGUST

Station Nos	Water Depth (feet)	Dominant Species	Bottom Cover (%)	Wet Weight (g/m^2)	Dry Weight (g/m^2)
1,2, 9 and 11	>5	*M. spicatum*	60	1568	248
8 and 10	4-5	*E. canadansis*	95	1112	196
3, 4 and 7	3-4	*M. spicatum*	75	840	124
5 and 6	2-3	*E. canadansis* *M. spicatum*	25	356	56

Table 3: Aquatic Plant Growths in Mitchell Lake - 1976

Station Nos	Water Depth (feet)	Dominant Species	Bottom Cover (%)	Wet Weight (g/m^2)	Dry Weight (g/m^2)
		JUNE			
1,2,3,4 and 5	4-5	P. richardsonii P. zosteriformis E. canadensis V. americana M. exalbescens	60	1096	136
6 and 7	3-4	Potamogeton spp. M. exalbescens Chara spp. V. americana	55	292	36
8	2-3	Potamogeton spp. V. americana M. exalbescens	80	812	80
		AUGUST			
1, 2, 3, 4 and 5	4-5	V. americana Potamogeton spp. N. flexilus M. exalbescens Chara spp.	95-100	1710	158
6 and 7	3-4	V. amerciana N. flexilus, Chara spp. M. exalbescens	100	1614	176
8	2-3	V. americana M. exalbescens Potamogeton spp.	95	1964	136

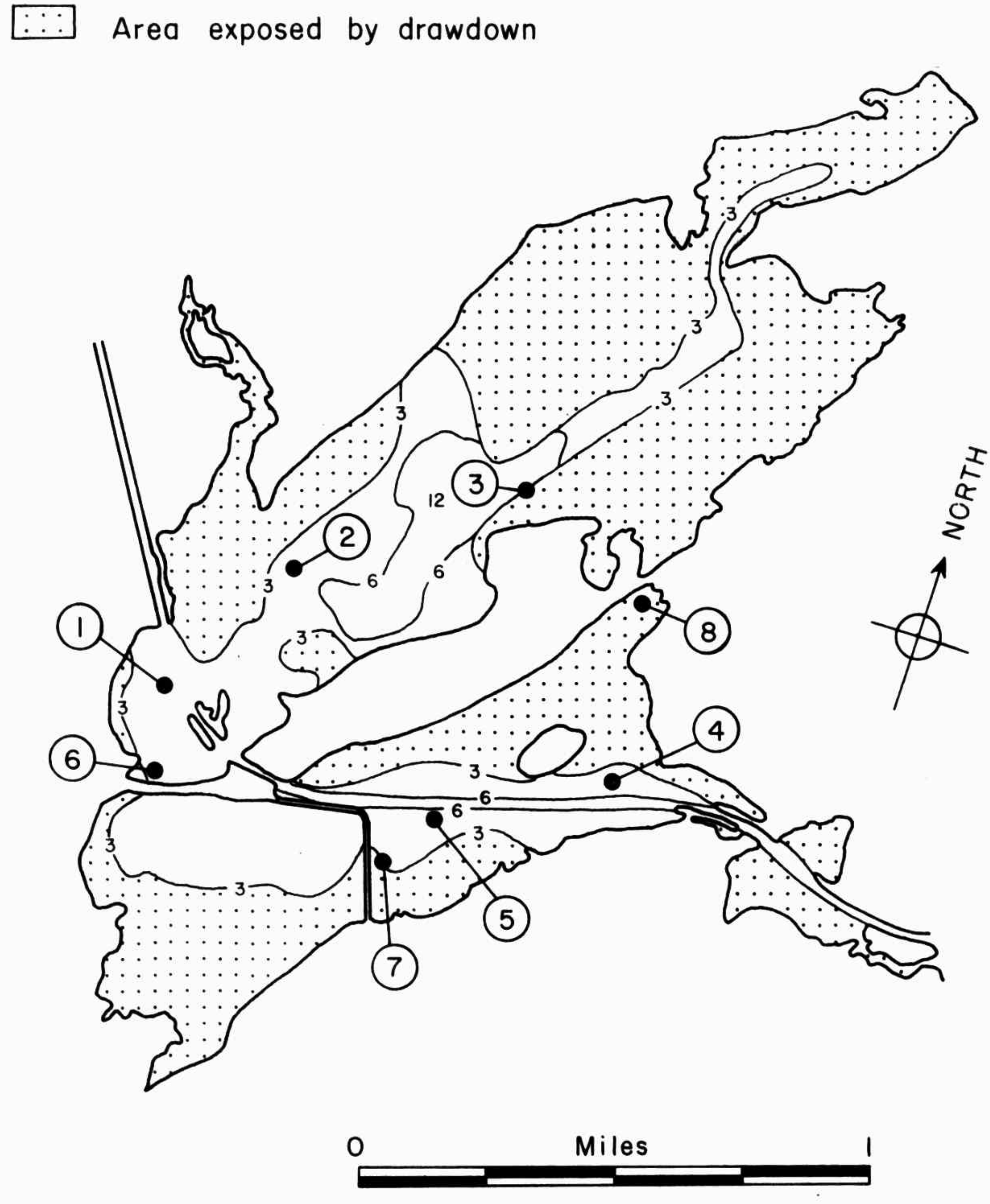

FIG. 2 Macrophyte sampling stations in Mitchell Lake in 1976, and approximate area exposed by annual drawdown.

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